SCIENTIFIC TECHNICAL DOCUMENT

The decrease in health expenditure associated with incorporating dietary treatment carried out by a dietitian-nutritionist into primary health care

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2019

Published by: Col·legi de Dietistes-Nutricionistes de Catalunya
Translated by: The Language Service of the Rovira i Virgili University
ISBN (digital edition): 978-84-09-15082-3
ISBN (print edition): 978-84-09-15081-6
1st edition: Barcelona, September 15th, 2019

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In the present document we have attempted to respect the non-sexist use of language. Nevertheless, because of its length we have not been exhaustive and on occasion we have used the generic masculine.

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TABLE OF CONTENTS

SUMMARY

Chronic diseases are currently the main causes of death in the world, and the health expenditure they generate is very high. The World Health Organization (WHO) and the leading scientific societies consider the prevention of obesity (especially in children) and cardiovascular disease to be a public health priority.

In addition, the increase in aging rate and life expectancy in industrialized countries is associated with the increased morbidity of the adult population, which increases the economic and human resources that must be used.

Today, there is no specialized care in the field of primary care (PC) to prevent and treat problems arising from an inadequate or unbalanced diet. It has been shown that it is necessary to incorporate the dietitian-nutritionist (D-N) in PC because most of the diseases in Catalan society are directly related to food (type 2 diabetes *melitus*, obesity, hypertension, hypercholesterolaemia and malnutrition in some cancers). These diseases generate the most healthcare costs and they can all be prevented by a change in lifestyle. In addition, PC is the most appropriate place to take action with the most disadvantaged sections of society, where these diseases are more frequent.

International and domestic studies confirm that incorporating D-Ns into PC saves considerable costs in medication, medical visits and hospital admissions. In New Zealand, it was found that for every dollar invested in dietary treatment, there is a saving of 6.40 USD in medication and hospital care. The Dutch Association of Dietitians found that every euro invested in a dietary treatment resulted in a saving of up to four euros in other health costs. At a national level, we have the example of PREDIMED (prevention with the Mediterranean diet), which has become a worldwide point of reference. It should be noted that treatments by other health professionals that focus on lifestyle changes have proven to be effective but not efficient, and only those carried out by D-Ns (the real specialists) obtain efficient results.

Therefore, the College of Dietitians-Nutritionists of Catalonia (CODINUCAT) uses scientific evidence to argue in favour of the importance of having D-Ns in PC and that they are a health investment because they prevent and/or treat diseases that are very expensive for the public health system. In addition, the prevention of obesity and cardiovascular disease should be a priority for public health and the WHO recommends monitoring and controlling these diseases with a comprehensive, multidisciplinary approach involving various health professionals, including the D-N.

ABBREVIATIONS

AEDN	Spanish Association of Dietitians-Nutritionists
AP	Primary care
BDA	British Dietetic Association
CODINUCAT	College of Dietitians-Nutritionists of Catalonia
DC	Dietitians of Canada
DAA	Dietitians Association of Australia
DKK	Danish crown
D-N	Dietitian-nutritionist
DPP	Diabetes Prevention Program
T2DM	Type 2 diabetes mellitus
ICER	Incremental cost-effectiveness ratio
LYG	Life years gained
NVD	Nederlandse Vereniging van Diëtisten (Dutch Dietetic Association)
WHO	World Health Organization
PCMH	Patient-Centered Medical Home
QALY	Quality-adjusted life years
WTP	Willingness-to-pay

INTRODUCTION

Health care and cost of chronic illnesses and aging

The incidence and prevalence of various chronic diseases, such as obesity, type 2 diabetes *mellitus* (T2DM) and other cardiovascular risk factors, are increasing worldwide [1,2]. In addition, the increase in aging rate and life expectancy in industrialized countries is related to an increase in morbidity of the adult population, which increases the financial and human resources required.

The scientific evidence available shows that proper eating habits can prevent the onset of many of these diseases, and even facilitate more metabolic control. This decreases the need for medical care (medical visits, hospital costs) and the cost of medicines, and also improves life quality.

According to the Catalan Institute of Statistics [3], the population over 65 years has increased gradually and steadily in recent decades, and will continue to increase. In 2017 primary care (PC) services received a total of 46,183,435 visits, representing an average of 8 visits per person. However, people 75 years old or more made more than 12 visits per year [4].

In Catalonia, dyslipidaemia, T2DM and high blood pressure are diseases that result in many inter-consultations in PC and generate high pharmaceutical costs. Of the population aged 15 or more who visited a PC centre, 21.6 % had dyslipidaemia, 9.3 % has T2DM and 22.5 % had hypertension. Despite the decline in prevalence of T2DM, the rate of hospitalization due to related complications during the year 2017 was 6.5 per 10,000 people attended, which is practically the same as in 2016. In terms of pharmaceutical expenditure, during 2017 the average number of prescriptions per user was 25.7, which represents a gross expense of 287.3 € per user. The standardized pharmaceutical cost for users in 2017 reached 303.3€ per user, 1.7 % more than the previous year. The gross cost of pharmacological treatments per user was: a) 208.7€ for antidiabetic insulin for T2DM; b) 67.9€ for antihypertensives; and c) 74.7€ for statins for treating dyslipidaemia.
[3, 4].

On a global scale, the total cost of cancer, including medical expenses, loss of income and the non-medical expenses, estimated for the year 2030 is 458,000 million dollars. Between 2010 and 2030, it is estimated that the total economic losses due to cancer, cardiovascular diseases, T2DM, chronic respiratory illness and mental illness will be 46.7 billion US dollars. This loss is equivalent to 75% of the world gross domestic product (GDP) in 2020 (63 billion US dollars) [5]. According to the International Agency for Research on Cancer of the World Health Organization (WHO), up to 50% of cancers can be prevented with a series of healthy habits, such as having a diet rich in fruit and vegetables, regular physical activity, walking 30 minutes a day and avoiding toxic habits such as tobacco or alcohol. Promoting changes in lifestyles is important to prevent these diseases. Along with screening measures and vaccination programs, PC needs to monitor that people have a healthy diet, avoid excessive exposure to the sun and carcinogens and live in a smoke-free space [6].

Along with screening measures and vaccination programs, PC needs to monitor that people have a healthy diet, avoid excessive exposure to the sun and carcinogens and live in a smoke-free area.

Malnutrition is also a common disorder among older people in Western society. According to the PREDYCES study, which assessed the prevalence of hospital malnutrition and associated costs in Spain, one in four people admitted to hospitals in the National Health System is at risk of malnutrition. *Malnutrition* is understood as the state resulting from a lack of intake or insufficient intake of nutrients that alter the body composition (decrease in fat-free mass) and the body mass of the body, which decreases the physical and mental functioning, and leads to the deterioration of the clinical results of the illness. Malnutrition can result from hunger, disease or the aging progress (for example, in people over 80 years), alone or in combination [7]. The risk of malnutrition is associated with longer hospital stays and more hospital costs, especially in people who develop this risk while in hospital. In Catalonia, according to hospital data, 17.5% of the people hospitalized had a nutritional risk, which represents an additional cost of 166,133,405€ [8]. Although malnutrition is more common in hospitalized elderly people and people who need long-term hospital stays, it is also a relevant and often unrecognized problem in society; where the prevalence of malnutrition varies between 15 % and 35 %, depending on the specific population of the study and the criteria used to define malnutrition [9 -11]. In Catalonia, the data of a study designed to establish the factors associated with the presence of malnutrition or risk of malnutrition

in people aged 65 and over in different health care centres in Lleida (primary care centres, hospitals for acute patients, sociosanitary centres and residences) revealed that 58 % of participants had a poor nutritional status. This malnutrition was related to sociodemographic and psychosocial factors, acute and chronic diseases, unintentional weight loss and eating and digestion factors [12]. In PC it is predicted that the number of malnourished elderly people will increase due to the aging of society [13]. Therefore, screening in PC is important to identify and treat malnutrition early and establish programs to help control it.

The current situation of the dietitian-nutritionist in primary care in Catalonia

Primary care is the most qualified care facility for taking on most preventative activities, including dietary counselling. For this reason, the College of Dietitians-Nutritionists of Catalonia (CODINUCAT), previously the Dietitian-Nutritionist Association of Catalonia, and the Spanish Association of Dietitians-Nutritionists (AEDN) have made great efforts to get the figure of the D-N incorporated into PC in Catalonia. In 2006 they produced a paper which proposed including the D-N in the Catalan Health System [14]. This study recommended placing D-N services in specialized PC centres and indicated two implementation models: one model that established a D-N coordinator between the hospital and basic health areas, and another model in which the D-N would collaborate on a non-daily basis (one day a week in different PC teams).

Years later, in 2009, the AEDN recommended including D-N services within the framework of the different areas of the National Health System [14, 15]. The AEDN proposal was to incorporate one D-N in PC for every 50,000 health cards to meet the nutrition and dietary healthcare needs of the population and promote effective and innovative PC [15]. More recently, in 2018, Dr Nancy Babio, President of CODINUCAT, made a presentation at the Health Commission in which she emphasized the importance of incorporating the D-N in PC to prevent chronic diseases such as obesity, T2DM, hypertension and cancer. She highlighted to the representatives of the parliamentary groups that an appropriate dietary treatment is essential for promoting health and preventing and treating these chronic diseases. These diseases are more prevalent in the population that has fewer resources. She emphasized that the prevalence of overweight children is alarming and therefore, “for the first time, children today will live less than their parents due to the advance of chronic diseases associated with obesity”.

She also highlighted several international and state studies that confirm that incorporating a D-N into PC saves considerable costs in medication, medical visits and hospital admissions. For example, in New Zealand for every dollar spent on dietary treatment there is a saving of 6.40USD in medication and hospital care. In the case of people with hypercholesterolemia, for every dollar invested there is a saving of 5USD in statins and other interventions. The Dutch Association of Dietitians found in a study carried out in 2012 that every euro invested in dietary treatment means a saving of up to four euros in other health costs.

Dr Babio also stressed that at a national level, we have the example of PREDIMED (Prevention with the Mediterranean diet), which has become a worldwide reference and has shown that a dietary intervention with the Mediterranean diet carried out by a D-N in PC can reduce by 30% the risk of suffering from cardiovascular disease and associated mortality. Based on the evidence, she stated that "D-Ns are an investment in health".

In New Zealand it has been shown that, for every dollar invested in dietary treatment, there is a saving of 6.40 USD in medication, hospital care and other health costs.

She also warned of the evils arising from miracle diets and advice from fake specialists, highlighting the recommendations for using plants and syrups for fighting cancer and other diseases, and that it is common in a medical consultation that the professional has to spend a good part of the time denying these falsehoods, which affect the population so badly.

However, currently D-Ns are not included in the services of the Catalan public health system. There are only isolated experiences in PC centres managed by private companies that offer dietetic and nutrition services through self-management systems (e.g. the PC centres of Riudoms, Marià Fortuny, la Selva del Camp, Vandellòs and l'Hospitalet de l'Infant and l'Hospital Lleuger Antoni de Gimbernat of Cambrils, managed by the Sagessa group) or through complementary health services that are not funded by the public purse of CatSalut (e.g. the PC centres of Vallcarca-Sant Gervasi and l'EAP d'Osona Sud-Alt Congost SLP).

Current situation of the dietitian-nutritionist in primary care in other countries

In Europe and other countries, such as Canada, Argentina, Brazil, the US, Australia and New Zealand, the D-N is already incorporated into the health system, where they are responsible for the dietary and nutritional care of the population to promote health and prevent and treat disease [16].

The opinion published in 2014 prepared by the European Commission and elaborated by the Expert Group on Health Systems Performance Assessment consider D-Ns as active professionals within PC teams, along with professionals of dentistry, family medicine, nursing, midwifery, occupational therapy, optometry, pharmacy, physiotherapy, psychology and social work [17].

Recently, the European Commission published the report *A New Drive for Primary Care in Europe: Rethinking the Assessment Tools and Methodologies* prepared by the Expert Group on Health Systems Performance Assessment [18]. This report states that a solid PC is the basis of an effective, efficient and responsive health system that is sensitive to people's needs. Moreover, although it is not sufficiently recognized, PC can handle most current chronic diseases without a reference specialist and produce benefits for the current health care systems [17]. A good PC performance implies using less health services in general, focusing more on quality of care and achieving optimum health outcomes.

A solid PC is the basis of an effective, efficient and responsive health system that is sensitive to people's needs.

PC is in a dynamic environment and has the constant responsibility to adapt to the population's needs. PC needs to be strengthened with an assessment of performance and smooth operation that encompasses all health professions working in multidisciplinary teams: dentistry, dietetics and nutrition, family medicine, nursing, midwifery, occupational therapy, optometrists, pharmacy, physiotherapy, psychology and social work. The performance assessment can help make decisions about the allocation of significant resources in health systems, ensure there are resources to support the expansion of the PC roles and functions, and ultimately achieve the level of excellence of services.

Therefore, in Europe, the D-N is a widely recognized figure and has a long history in exercising the profession.

The British Dietetic Association (BDA) is the only organization in this country that represents all D-Ns. The BDA was founded in 1936 and now, with more than 9,500 members, is the D-N association and union of Great Britain and Northern Ireland. Currently, 70 % of the members of the BDA work in the National Health Service (NHS) of the United Kingdom. Most of the D-Ns of the NHS work in secondary care, although a significant proportion also work in the PC community.

> **In the United Kingdom, 70% of British Dietetic Association members work in the National Health Service in the United Kingdom.**

In Holland, the Nederlandse Vereniging van Diëtisten (NVD), the Association of Dietitians of Holland, is the professional association of Dutch D-Ns. The NVD, established in 1941, has more than 2,800 members. Most Dutch D-Ns work in hospitals or in PC. The number of D-Ns has increased significantly in recent years because dietary treatment is covered by the basic medical insurance for four hours per person per year. In January 2011, approximately 55% of all D-N worked in PC (i.e. private practice or home care), 35% in secondary care (hospital care or nursing homes), 3% in tertiary care (e.g. institutions for people with intellectual disabilities) and 7% in other environments (e.g. in commercial organizations or teaching) [19].

D-Ns have a long history in countries like the United States [20], Argentina, Brazil and Canada. In the United States, the Academy of Nutrition and Dietetics, formerly known as the American Dietetic Association, is the organization of nutrition and food professionals and has more than 75,000 members, including D-Ns. D-Ns in this country provide professional services such as nutritional medical therapy to those people who have Medicare insurance (basic insurance program for people over 65 and people with disabilities) with medical coverage (called Medicare “part B”), some state Medicaid programs (programs that help with medical costs for certain people with low incomes) and all the main private medical insurances [21]. In the United States they have worked to create new models that include health insurance D-N services within PC [22, 23]. These models highlight the key role the multidisciplinary team plays to achieve good care for people. The role and value provided by the D-N is recognized among the team members [24]. For example, the Medicare insurance with medical coverage covers medical nutrition therapy by a D-N for those who have T2DM, kidney disease or who have had a kidney transplant in the last 36 months [25]. In addition, the insurance covers the medical revisions of behavioural counselling for obese people (if they have a BMI ≥ 30 kg/m2). This consists of a dietary assessment and monitoring to help the person lose weight through diet and physical activity [26].

In Canada, **Dietitians of Canada (DC)** represents more than 5,000 D-Ns. It has been estimated that 17.5% of people attending a family health network (equivalent to a health centre) requires an action in relation to diet and nutrition, and establishes a population assistance rate to a D-N for every 15,800 to 29,000 people per year [27]. The Canadian D-Ns support access for all Canadians to appropriate services by the right professional at the right time to address their health needs [28].

In Argentina, the **Asociación Argentina de Dietistas y Nutricionistas Dietistas (AADYND)** is a non-profit scientific and professional institution that was founded in 1947 and includes dietitians, nutritional dietitians and those with a degree in nutrition. The D-N is part of the staff who works at PC centres [29]. The PC centres are family health units (USF) that include family medicine professionals, nurses and health workers (called "promoters"), plus a support team with professional social workers, nutrition professionals and others that are necessary depending on the profile of each population group. They are managed by a coordinator or coordination team. Each family health unit corresponds to a population of up to 3,000 people (this would be the "contingent of people" of each family doctor) [29].

In Brazil, the **Associação Brasileira de Nutrição (ASBRAN)** was created in 1949. ASBRAN aims to promote and strengthen the training and specialization of nutritionists, promote research and contribute to the dissemination of nutrition in Brazil, so that this science and its professionals are recognized as fundamental for healthcare. ASBRAN defends the importance of the role played by D-Ns in PC. The D-N plays an important role in the PC centre, given that they are the professional who can enhance dietary and nutrition actions [30, 31], especially strengthening the technical knowledge of other health professionals, in order to face the challenges of the epidemiological scenario [32, 33].

In Australia, the **Dietitians Association of Australia (DAA)**, formerly the Australian Association of Dietitians, was founded in 1976 and has more than 6,300 members. Australian D-Ns are also part of the PC team and offer nutritional counselling to help change eating behaviour [34].

In New Zealand, the **Dietitians New Zealand (Dietitians NZ)** is the professional association of D-Ns and has more than 600 members. The D-N is also qualified to contribute to the quality of PC through a coordinated team of health professionals with complementary skills who work together to provide different aspects of general care [35].

EXPERIENCES WITH THE ROLE OF THE DIETITIAN-NUTRITIONIST IN PRIMARY CARE

In Europe, the United Kingdom is the country that provides most information about the role of the D-N in PC. In the United Kingdom, the BDA believes that the D-N plays a key role in supporting PC services [36]. The BDA has recently published a report that describes the central role that the D-N can play within PC. In this paper, the authors propose expanding the role of the D-N within PC by creating a recognized specialization called D-N general expert [37]. With this specialization, the D-N would be included as a core member of the general professional team. The report details the work of the D-N in this new role, working together with the family doctor (GP) to:

a. Help people care for themselves.

b. Reduce the time demand on the GP.

c. Promote health and prevent diseases in PC.

d. Effectively and efficiently manage medication.

e. Effectively and efficiently manage the products of the Advisory Committee for Borderline Substances, which includes oral nutrition supplements, enteral nutrition for probes, other food products and some toiletries (for example, toothpaste) [38].

f. Reduce the need for costly referrals to secondary care or the need for hospitalization.

g. Use technology effectively, and form part of the multidisciplinary PC team.

Table 1
Responsibilities of the dietitian-nutritionist general expert [37]

Attending to people with a wide range of illnesses or health problems

Obesity, T2DM, gastrointestinal diseases (for example: irritable bowel syndrome, celiac disease, inflammatory bowel disease), dementia, some neurological diseases, cardiovascular diseases (for example: heart disease and stroke, high blood pressure), cancer, diseases associated with malnutrition (enteral nutrition), retardation of growth in children, inherited metabolic diseases, food allergies, kidney, liver or pancreatic diseases, among others, through different channels (face-to-face consultations, email, phone or Skype at PC centres).

Attend to people who do not have a referral but who have a set of established and consensual symptoms

Or health problems. The D-N would be trained to make an initial assessment to send to the family doctor, depending on the symptoms the patient has.

Receive and attend people who have been referred

By family medicine professionals, nursing staff, or the nursing staff of nursing homes or other health professionals such as speech and language therapists.

Prescribe appropriately for the care of long-term health problems

For example, in the cases of T2DM, kidney disease and pancreatic disease.

Manage the proper use of nutritional supplements and food.

Carry out health promotion activities

Such as health checks to be able to propose changes in the behaviour of the person when necessary.

Offer health education sessions

(Often together with other health professionals); for example for T2DM, weight control, etc.

Provide training in nutrition

For PC professionals and nursing staff of nursing homes, such as screening for malnutrition, make appropriate referrals, etc.

Regularly evaluate compliance with dietary advice

In PC in the UK there is also the D-N specialized in prescribing support dietitian products, who works mainly in PC centres and medication management teams in groups of clinical commissions to improve prescribing nutritional products effectively and appropriately. Much of the work of the D-N with this specialty consists in identifying and treating malnutrition, first through a nutritional approach or diet optimization, and then by guaranteeing the appropriate prescription of oral nutritional supplements. This task ranges from the individual assessment of people to joint work with carers, residential and community services, providing health education when necessary. Data from the audits carried out in the PC centres indicate that up to 75% of prescriptions of oral nutritional supplements for adults were not appropriate according to the prescription criteria of the clinical commissions and the opinion of the D-N [38]. In Catalonia, prescribing oral nutritional supplements depends on the home enteral nutrition teams of each hospital, so that professionals, not always D-Ns, control their use. In other regions of Spain, since most of the prescriptions are made without the screening of a nutrition and dietetics professional, it is very possible that that the dietary options are not being optimized before oral supplementation is prescribed.

The BDA has commissioned the University of Plymouth to undertake a research project to provide firm evidence of the effectiveness of D-Ns working in PC. This will give them clear proof of the need to hire more D-Ns in PC. This work is supported by Health Education England, and is expected to be published by the end of 2019 [39].

In other European countries, such as Holland, the D-N often treats people who have T2DM, chronic obstructive pulmonary disease, cardiovascular diseases or people at risk of cardiovascular disease [40]. D-Ns also play an important role in the care and treatment of malnutrition. In 2010 the work group formed by the Dutch College of General Practitioners (Nederlands Huisartsen Genootschap, NHG), the Dutch Association of Nurses (Verpleegkundigen & Verzorgenden Nederland, V & VN) and the Dutch Association of Dentists (Nederlandse Vereniging van Diëtisten, NVD) wrote the National Primary Care Collaboration Agreement (Landelijke Eerstelijns Samenwerkings Afspraak, LESA). The Agreement (2011) was designed to achieve better PC for adults with the risk of malnutrition and a tighter cooperation between family doctors, nurses and D-Ns [41]. Recently, the D-Ns of PC realised that family doctors do not do routine nutritional screenings and they consider that it is necessary to previously consult a D-N to provide appropriate nutritional care [42].

At PC centres the family doctors do not make routine nutritional screenings. A D-N should be consulted beforehand to provide adequate nutritional care.

In other countries, such as Canada, the USA, Australia and New Zealand, the D-N plays an important role in PC.
In Canada, they are valued members of the health team (Table 2). They also provide leadership to support nutritional health through health promotion, disease prevention, treatment, support and rehabilitation. The primary care D-N works in public health centres, medical centres and other wellness and PC centres [43]. Their tasks include making nutritional interventions designed to meet the patient's lifestyle; applying health promotion strategies in collaboration with the interprofessional health care team; leading the interprofessional team on maternal-child nutrition, growth and development as well as optimal early detection of eating disorders; developing management initiatives for healthy lifestyle programs for preventing and treating childhood obesity; and providing education in nutrition in schools and food skills development programs [44].

Table 2
Roles of the Canadian dietitian-nutritionists in primary care [45]

ROLES	EXAMPLES
Promoting health	**Constructing healthy public policy:** Work with dietary advice for society, establishing "healthy population" policies in different sectors to ensure access to healthy food choices, e.g. schools, work places.
	Creating support environments (work and leisure conditions favour healthy choices): Contact the catering service of work places and educational institutions to propose healthy menu options.
	Strengthening community action: Manage and train workers in programs oriented towards vulnerable populations (pregnant teens, the elderly) and in programs for promoting food safety (e.g. the community of food/nutrition advice program).
	Developing personal skills: Work with groups of elderly people and people diagnosed with mental diseases to give support for having a healthy diet.
	Reorienting health services: Train other professionals in medicine, nursing, etc., and from other sectors (social services, education, etc.) in basic nutrition and promote health to complement, not replace, the knowledge of the D-N.
Preventing illness	Develop educational materials to promote cardio-healthy nutrition for people with a high lipid profile.
Treatment	Provide nutrition and lifestyle advice to reduce the risk of developing chronic diseases.
Rehabilitation/ support	Give nutritional support (including the enteral and parenteral nutrition at home) to optimize the state of health in palliative care, trauma, dysphagia, etc.

In the United States a promising model, called the Patient-Centered Medical Home (PCMH), has been created to transform how PC is organised and provided [46]. PCMH places emphasis on preventing and caring for comorbidities. There are several studies that have shown that medical nutrition therapy provided by a D-N improves health outcomes related to chronic diseases, such as T2DM, lipid metabolism disorders, obesity, and hypertension [47]. PCMH provides healthcare that includes several services related to nutrition: "provision of PC, which includes, among others, acute and chronic care services and prevention services"

PC medical professionals see that including D-Ns into their health teams has benefits. Studies have shown that doctors believe that the food and nutrition approach is important for promoting the health care and treatment of people, but the group does not feel sufficiently trained to provide optimum food advice.

PC medical professionals see that there are benefits of including D-Ns in their health teams. Studies have shown that doctors believe that the food and nutrition approach is important for promoting the health and treatment of people, but the group does not feel sufficiently trained to provide optimal dietary nutrition advice. DNs have unique competencies related to assessment and the focus of multidisciplinary teams, which are fundamental elements of a PCMH. DNs traditionally work with other team members to provide evidence-based and person-centred care, and have proven effective in facilitating support for self-management. D-Ns have shown to have great management and operation skills and have the necessary abilities to work as case and care managers in the PCMH.

In Australia, D-Ns are part of the Health Professional Collaborators, which is the leading national organization for health-related professions. These professionals offer PC both in public and private employment. Consultations can be covered through private health insurance plans, though not through Medicare. The exception is people who have chronic illnesses and complex health problems, who are entitled to Medicare discounts for five healthcare services and three dental services when the family doctor refers them. People, who responded to a DAA survey about D-Ns working in Medicare centres (the PC organization in Australia [48]) in 2014, indicated that D-Ns addressed food as a contributor to the prevention and care of chronic diseases through:

a Medical nutrition therapy for chronic diseases, including T2DM, cardiovascular diseases, kidney disease, obesity, gastrointestinal disorders, cancer, food allergies and food intolerances.

b Education and training for health professionals, community support workers, food service workers and students.

c Disease prevention programs between acute health services and PC centres [49].

New Zealand D-Ns contribute to quality primary care. In this environment, DNs work with a wide range of parameters related to health and nutrition that make it possible to improve the nutritional status both individually and populationally. An effective PC requires a coordinated team of health professionals with complementary abilities who work together to provide different aspects of general care. The members of NZ Dietitians are well prepared to make a positive contribution to the integrated PC, which is easily available and effective [35]. In fact, in New Zealand it has been shown that dietary intervention shows significant statistical and clinical impacts on health outcomes in the areas of obesity, cardiovascular disease, T2DM and malnutrition in the elderly, compared to usual care. These impacts give support to the D-N working in PC, since their role can have large economic benefits, and save money for the New Zealand healthcare system [50].

SCIENTIFIC EVIDENCE OF THE EFFECT OF NUTRITIONAL AND DIETARY TREATMENT IN PRIMARY CARE

Clinical benefits of dietary-nutritional treatment for frequent chronic diseases

According to the World Health Organization (WHO), non-transmissible diseases, such as cardiovascular diseases, cancer, T2DM and chronic respiratory diseases, cause 70% of deaths around the world, and are the leading cause of death [51]. These diseases have modifiable risk factors, such as habits like smoking, an unbalanced or unhealthy diet, a sedentary lifestyle and alcohol abuse, which cause excess weight and obesity, hypertension, dyslipidaemia, etc. According to WHO, many of these deaths could be delayed and even avoided by applying interventions based on changes in lifestyle. In this same line, the World Cancer Research Foundation and the American Institute for Cancer Research affirm that, although some risk factors for cancer are not modifiable (hereditary factors, for example), a wide range of modifiable factors, such as lifestyle or environmental factors, affect the risk of cancer [52]. Thus, between 30% and 50% of cancers could be prevented by modifying these risk factors. Old age also carries an added risk of malnutrition and associated comorbidities if there is poor nutrition [53], and increases the risk of hospitalization and morbimortality. It is a widely demonstrated fact that dietary and nutritional treatment is effective, achieves clinical benefits and reduces the risk of morbidity and mortality.

Economic benefits of dietary and therapeutic treatment in primary care

Chronic diseases related to nutrition entail an increase in the healthcare costs associated with more visits to health centres (generalists and specialists), and more healthcare income and expenses in medication. In addition, there is also currently a lot of evidence that investing in nutritional dietetic treatment in PC is effective.

There are different methods for assessing the economic benefits of health treatments. The first is to analyse only the costs of any treatment (cost minimization analysis).

This method, would not consider the potential benefits of a method reducing the complications of the disease, and would always choose the cheaper method, and thus it is not a good method for these economic comparatives. Cost-effectiveness analyses measure/compare the treatments in units achieved (for example: pounds, dollars or euros for each kilogram lost or each *Life Year Gained* (LYG), and cost-utility analyses, the most recommended, relate the costs of the treatment to the *Quality-Adjusted Life-Years* (QALY). That is, life expectancy is adjusted according to the existence of diseases or chronic health problems that reduce life quality. Thus, 1 QALY is equivalent to 1 year in perfect health or 2 years with half health. Normally, an intervention is considered acceptable if the cost of putting it into practice is 20,000-30,000 £/QALY gained. Finally, the cost-benefit analysis is the broadest measure because it even goes beyond health measurements, and broadens the objectives to monetary terms (measuring the benefit in willingness to pay). In many cases, the different authors use incremental cost-effectiveness ratios (ICER); for example, the ICER for QALY gained, or ICER per centimetre of reduced waist, etc. to assess whether the treatment is cost-effective or not. Most studies use cost-effectiveness and cost-utility analyses.

To study the cost-effectiveness of dietetic-nutritional treatment in PC, a bibliographic search was made on 15 February, 2019 using the PubMed Central and Cochrane Library databases. The search was made in all the articles published after the year 2000 and included the following search terms: *primary care, primary health care and general practice; dietetic, dietary, nutritional, lifestyle and diet; therapy, treatment, intervention, counselling* and *advice, and cost-savings, cost-effectiveness, cost-benefit* and *economic savings.* Two independent researchers carried out the review. Later, all the studies that had not been carried out in PC or that did not analyse the economic benefits of the treatments were excluded.

From this review we obtained a total of 36 intervention studies and/or systematic reviews that evaluated the cost-effectiveness of dietetic-nutritional treatment in PC, which is detailed below according to the basic pathology of the people.

Excess weight

In Spain, excess weight (overweight and obesity) has increased in recent years. If the current tendency continues, between 2016 and 2030 there will be 3,100,000 new cases of people who are overweight, which will entail an expense of 3,000,000,000 euros/year in additional direct medical costs (considering these expenses as the sum of the cost in PC, specialized care, visits to emergency services, hospitalization, analyses or other types of diagnostic tests and pharmacological prescriptions). Currently, the additional medical costs associated with excessive weight represent 2% of the health budget, but if the trend continues, 16% more cases are predicted for the year 2030 and 58% more direct additional costs, which could be saved by controlling these obesity figures [54].

Only a few studies (Table 3) have made a rigorous economic analysis of dietetic and therapeutic treatment programs for treating obesity and the associated cardiovascular risk factors. In fact, the only systematic review published in the Cochrane database on the subject [55] concludes that there are few studies that evaluate the economic management of this type of intervention (only two in this review and they only measure costs and cost-effectiveness); therefore, more studies are necessary to be able to evaluate the economic efficiency of these interventions. Similarly, in another systematic review published by Loveman *et al.* [56], the authors expose the poor quality of the analysis of the cost-effectiveness of this type of program, including only two citations in their review. According to the authors, for each QALY gained with interventions, £473 can be saved in one of the studies, or £7,200 (12,640 USD) extra spent for each QALY gained with the different nutritional interventions in the other study. However, these data must be interpreted with great caution due to the methodological limitations of the results. Robertson *et al.* [57] found similar methodological problems in a systematic review of the treatment and economic management of obesity in men, and concluded that the evidence about the economics of managing obesity in men was scarce and heterogeneous. They were only able to include three studies on dietary intervention, and these studies indicated that intervention based on changes in lifestyle can be highly cost-effective in overweight and obese men.

There are several randomized, controlled, economic studies of nutritional treatments that have different results.
Hagberg *et al.* evaluated the cost and effectiveness of a postpartum dietetic treatment program in PC (versus regular control/treatment). The cost-effectiveness analysis determined quality-adjusted life years (QALY) and cost-effectiveness ratios, and demonstrated that the dietary treatment was cost-effective [58]. Little *et al.* [59] also demonstrated that an intervention based on behavioural treatment via the Internet

with the support of PC nurses was cost-effective, and demonstrated that significant weight loss can be achieved without any increase in healthcare costs. McRobbie *et al.* [60] compared in PC the effect of a conventional nutritional treatment carried out by nurses with an intensive group program to lose weight, and demonstrated that the program was cost-effective (7742 £ per QALY, the ratios between 20,000 and 30,000 £ per QALY gained are considered effective).

The Dutch D-N association also worked intensively on this topic, and in 2012 published a document analysing the cost-benefit of nutritional treatment with a D-N

The Diabetes Prevention Program was demonstrated to be effective, and was able to reduce the probability of T2DM, the risk of serious complications and the possibility of dying due to a complication related to T2DM in high-risk individuals. It was also shown that the dietary intervention was cost-effective.

for people who are overweight or obese [61], taking into account that overweight and obese people usually do not only have excess weight, but also other related comorbidities. The document shows that dietetic-nutritional treatment generates benefits of 0.4 to 1.9 billion euros in a period of five years, so that, for each euro invested in dietary advice for these people, society receives between 14 and 63€/56€ in terms of health improvement (measured in QALY), 3 € in the form of savings in healthcare costs (savings in medication, hospital admissions) and 4€ in productivity gains (less work absenteeism and improved productivity).

In contrast, the weight loss program analysed by Tsai *et al.* [62] was not cost-effective, since the costs were larger in the intervention groups and there were no significant differences in the QALY gained, so that the authors indicate a possible improvement in the relationship between the cost and long-term effectiveness. Subsequently, in a new study, Tsai *et al.* [63] analysed the medication costs associated with two weight loss programs (six months of intensive lifestyle change treatment with later randomization of standard or intensive maintenance), and did not find any differences between the two groups. The authors conclude that more studies are needed, since they do not measure other economic parameters apart from the costs associated with the medication.

Fuller *et al.* [64] compared the usual care received in PC with a commercial program (Weight Watchers) for weight loss, and demonstrated that intensive nutritional treatment achieved profitable cost-effectiveness ratios.

Table 3
Economic studies on nutritional treatment for overweight

Study	Study type	People in charge of the intervention programme	Size of the sample and length of follow up	Description	Results
Flodgren *et al.*, 2017 United States and Australia	Review of randomized controlled trials.	Various health professionals.	12 randomized controlled trials, only 2 of which provide economic details.	**1.** a) HT *vs.* email. b) GT *vs.* telephone call. **2.** a) HT *vs.* D-N. b) HT *vs.* D-N + doctor.	Cost of 42.18 USD (HT) *vs.* 50.45 USD (email). Cost per kg lost: 71.50 USD (HT) *vs.* 72.08 USD (email). Cost: 42.18 USD (HT) *vs.* 39 USD (telephone). Cost per kg lost: 71.50 USD (HT) *vs.* 132.70 USD (telephone). Cost: 23.12 USD (HT) *vs.* 64.21 USD (D-N). Cost: 23.12 USD (HT) *vs.* 88.61 USD (D-N + doctor).
Loveman *et al.*, 2011 United States and United Kingdom	Systematic review of randomized controlled trials.	Various health professionals.	12 randomized controlled trials, only 2 of which provide economic details.	1. LSC *vs.* no treatment 2. LSC *vs.* HT.	Gain: 0.056 QALY. Reduction in costs: £27. Incremental cost-effectiveness ratio (ICER): –£473 /QALY gained (cost reduction). Gain: 0.24 QALY. Extra costs: 3.080 USD. Incremental cost-effectiveness ratio (ICER): 60,390 USD (£36,000) / LYG and 12,640 USD (£7,600)/QALY gained.
Robertson *et al.*, 2014 United KIngdom	Systematic review.	Various health professionals.	26 studies, only 5 of which provide economic details; only 3 have a nutritional intervention.	1. LSC *vs.* HT. 2. D-N/doctor *vs.* HT. 3. LSC *vs.* HT.	Incremental cost-effectiveness ratio: ICER < 2.000 CHF (Swiss francs) or £1,000/QALY. 92-98% probability of being cost effective with a WTP of 1,000 CHF/QALY gained. + 0.0002 LYG/+ 0.1210 LYG. No data on QALY/WTP.
Hagberg *et al.*, 2019 Sweden	Randomized controlled trial.	Dietician-nutritionist.	Women in intervention group N = 54, women in control group N = 56. Weight loss during postpartum. 2-year follow up.	Dietary intervention *vs.* leaflet.	Cost: 1,704–7,889 USD /QALY gained. Probability of being cost effective: 77-100 % with a WTP 50,000 USD per QALY.
Litle *et al.*, 2016 England	Randomized controlled trial.	Nursing.	Control group (N = 279), web + nursing follow up (N = 269) or web + remote nursing follow up (N = 270). 12 months.	Dietary intervention + nursing follow up (control group), dietary intervention via web + nursing follow up or dietary intervention via web + remote nursing follow up.	Costs + £18/kg (web + nursing) and –£25/kg (web + remote). 88-98% probability of being cost effective at a threshold of £100/kg lost.
McRobbie *et al.*, 2016 United Kingdom	Randomized controlled trial.	Psychologists.	N = 330. Weight loss programme (N = 220) *vs.* nursing intervention (N = 110). 12 months.	Weight loss programme (1 session per week/8 weeks) *vs.* nursing intervention (4 sessions in 8 weeks with LSC).	Programme costs: £195 per person vs. £176 for nursing intervention. Increase in QALY with the Programme: 0.0104 QALY. There are no differences in the habitual cost (habitual nursing intervention: £80). ICER £7,742/QALY; 68-77% probability that the Programme is the most cost-effective intervention.

Study	Study type	People in charge of the intervention programme	Size of the sample and length of follow up	Description	Results
Lammers *et al*., 2012 Holland	Cost-benefit analysis.	Dietician-nutritionist.	—	Nutritional treatment carried out by a D-N.	Benefits: 0.4-1.9 billion euros in 5 years. For every € invested, society receives €14-63: €56 in health improvements (QALY), €3 in saving (medication, income) and €4 in work productivity.
Tsai *et al*., 2013 United States	Randomized controlled trial.	Weight-loss coach.	HT (N = 130), brief dietary advice on LSC (N = 131), brief improved dietary advice on LSC (N = 129). 2 years.	HT (termly visits to PC) *vs*. brief dietary advice on LSC (+ monthly dietary advice) *vs*. improved brief dietary advice on LSC (+ monthly dietary advice + medication / meal substitutes).	Costs: +292 USD per kg lost per year on improved dietary advice vs. HT. QALY gained with no significant differences, so the programme could be profitable in the long term.
Tsai *et al*., 2015 United States	Randomized controlled trial.	Not specified. Primary care team.	N = 79. 18 months.	6 months of intensive LSC treatment, randomization subsequent to standard or intensive maintenance.	There are no changes in medication costs between groups. There are no other economic measures.
Fuller *et al*., 2013 Australia (A), United Kingdom (UK) and Germany (G)	Randomized controlled trial.	Commercial programme.	N = 772 adults. 12 months.	HT *vs*. «Weight Watchers» programme.	Costs per kg lost per year: HT: 138 USD (A), 151 USD (RU) and 133 USD (AL) Weight Watchers: 122 USD (A), 90 USD (UK) and 180 (G) ICER Weight Watchers with respect to SC: 18,266 USD (A), 12,100 (RU) and 40,933 (G).
Robertson *et al*., 2017 United Kingdom	Randomized controlled trial.	Facilitators/coaches; various health professionals.	6 to 11 year-old obese or overweight children. 15 families (128 children). 12 months.	HT *vs*. "Families for Health" programme.	There are no differences in the BMI with the Z-score at 12 months. Higher costs in the programme "Families for Health" (£998 vs. £548). ICER: £552,175 per QALY gained.
Hollinghurst *et al*., 2013 England	Randomized controlled trial.	Not specified.	Obese children (N = 143). 12 months.	a) multidisciplinary hospital team with D-N (control group, 2 arms) *vs*. b) PC nursing repeating control work *vs*. c) intensive programme on lifestyle changes.	Cost per child: a) £263 and £209 b) £301 c) £1749 Reduction in BMI a) 0.15 and 0.14 b) 0.17 c) 0.40

ICER: incremental cost-effectiveness ratio; LSC: lifestyle changes; HT: habitual treatment; D-N: dietician-nutritionist; WTP: willingness-to-pay; LYG: life-years gained; PC: primary care; QALY: quality-adjusted life-years

In children, the Families for Health [65,66] program assessed the cost-effectiveness of a family-based program led by coaches for controlling excess weight and obesity. Unfortunately, the program did not achieve more weight loss and costs were higher, so the authors considered the program to be non-cost-effective compared to the control group (ICER was too high, 552,175 £ for QALY gained and more costs: 998 £ compared to 548 £). Hollinghurst *et al.* [67] compared the effect of the specific treatment on childhood obesity in the hospital field (multidisciplinary team with D-N) with the treatment carried out in PC by nurses (reproducing treatment in the hospital setting) and with an intensive program for behaviour change. The intensive program was more effective, but much more expensive. Wolfenden *et al.* [68] wanted to review the different programs or strategies for improving the implementation of policies or practices for preventing childhood obesity; however, none of the studies reported the cost-effectiveness of the interventions.

Type 2 diabetes mellitus

Several studies have also evaluated the dietary advice for preventing and treating T2DM (Table 4). Bertram *et al.* [69] demonstrated the effectiveness of the changes of lifestyle in the treatment of pre-diabetes, and showed that changes in diet and physical activity obtained a better cost-effectiveness ratio than medical treatment. Leal *et al.* [70-72] estimated the cost effectiveness of the structured program Let's Prevent for the prevention of T2DM people with pre-diabetes, which included 44 PC doctors in Leicestershire (England) and about 880 participants with prediabetes. The intervention group gained a profit of 0.046 QALY in three years and an additional cost of 168£ per person, compared to the standard group. The increase in cost-effectiveness ratio (3643£/QALY) had an 86% probability of being cost effective.

The Diabetes Prevention Program was demonstrated to be effective, and was able to reduce the probability of T2DM, the risk of serious complications and the possibility of dying due to a complication related to T2DM in high-risk individuals. It was also shown that the dietary intervention was cost-effective.

The lifestyle change program Diabetes Prevention Program (DPP) [73, 74] also proved to be effective and in people with high risk reduced the probability of having T2DM, the risk of serious complications and the possibility of dying from diabetes-associated complications. It demonstrated that the dietary intervention was cost-effective [74] but not in all the analyses carried out [73]. Neumann *et al.* [75] studied the cost-effectiveness of a T2DM prevention program by comparing a group intervention (with changes in lifestyle) with a control group with no intervention and analysing the QALY and cost-effectiveness ratio between the two groups. The researchers demonstrated that the delay in the onset of T2DM is feasible and cost-effective.

In Catalonia, Sagarra *et al.* [76] transfered the results of the Europe-Prevention Using Lifestyle, Physical Activity and Nutritional intervention (DE-PLAN) to Catalonia. They analysed the costs of the intensive lifestyle change treatment and compared them with standard treatment costs. They showed that it is only necessary to invest 746€ in individual treatment or 108€ in group treatment to avoid each new case of T2DM. There has also been another important study carried out in our area, the PREDIMED multi-centre study, which demonstrated the effectiveness of a nutritional intervention for reducing the incidence of T2DM [77] and metabolic syndrome [78], as well as reducing by 30% cardiovascular disease and related

mortality and all causes in people with high cardiovascular risk [79]. In this case, the dietary counselling carried out by D-Ns was key to ensuring that people stuck to the Mediterranean diet and therefore changed their diet patterns [80].

Some studies have also assessed the cost-effectiveness of nutritional treatment for gestational diabetes. Broekhuizen *et al.* [81] conducted an economic analysis in nine European countries, and randomly placed 435 pregnant women at risk of gestational diabetes (PC and secondary) into different treatment groups: a) healthy diet and physical activity, b) healthy diet, or c) physical activity. In comparison with the standard treatment, the intervention was cost-effective (QALY after delivery). Also in gestational diabetes, Kolu *et al.* [82] studied 399 pregnant women with at least one risk factor for gestational diabetes. The women were re-randomized into regular monitoring or an intensive program of diet and physical activity carried out by nursing and physiotherapy professionals at the PC centre. The results showed that an additional 7€ was necessary to prevent the increase of 1g of body weight of the baby at birth, and the authors concluded that the program was effective but not cost-effective.

Pronk *et al.* [83] and Li *et al.* [84] made a systematic review to evaluate studies that contributed economic data on the benefits of nutritional therapy for adolescents or adults at high risk of T2DM and found an average cost-effectiveness ratio of 13.761 USD/QALY gained. Therefore, they recommended using programs for providing nutritional support and advice to people with this kind of risk because the economic evidence shows that these programs are cost-effective.

Table 4
Economic studies on nutritional treatment in diabetes

Study	Study type	People in charge of the intervention programme	Size of the sample and length of follow up	Description	Results
Bertram *et al*., 2010 Australia	Simulation model.	—	—	Analysis of the impact of 6 interventions: 3 drugs and 3 LSC (diet, exercise, diet + exercise).	The most cost-effective option is diet + exercise: cost-effectiveness ratio: 22,500 AUD/DALY; followed by metformin.
Leal *et al*., 2017 England	Randomized controlled trial.	Trained educators.	N = 880 880 participants with prediabetes. 3 years.	HT *vs*. «Let's Prevent» programme.	+ 0,046 QALY; + £168 /3 years with the intervention group. ICER: £3,643/QALY, with an 86% probability of being cost effective and a WTP threshold of £20,000/QALY.
Eddy *et al*., 2005 Hermann *et al*., 2005 —	Simulation model.	—	—	«Diabetes Prevention Program» *vs*. Intervention with placebo.	In comparison with no intervention, decreased risk of diabetes and comorbidities. 1,100 USD/QALY gained.
Neumann *et al*., 2017 Sweden	Simulation model.	—	—	LSC in diabetes *vs*. HT.	IICER: €3,833-9,215 /QALY gained. 85-91% probability of being cost effective, with a WTP threshold of €50,000/QALY.
Sagarra *et al*., 2014 Spain	Prospective cohort study.	Primary-care team.	N = 2.054 participants without diabetes. 4 years.	HT *vs*. CEV group LSC *vs*. individual LSC.	Cost-utility ratio: €3,243/QALY gained.
Broekhuizen *et al*, 2018 Europe	Randomized controlled trial.	Coaches.	N = 435 pregnant women, high risk of gestational diabetes.	HT *vs*. . healthy diet *vs*. physical activity *vs*. healthy diet + physical activity	With a WTP of €600/kg-€750/kg, 90-95% probability of a healthy diet + physical activity more effective than HT.
Kolu *et al*., 2013 Finland	Randomized controlled trial.	Infermeria + fisioteràpia.	N = 399 pregnant women with at least 1 risk factor of gestational diabetes.	HT *vs*. intervention.	To prevent an increase of 1 g body weight at birth, there is an additional cost of €7.
Pronk *et al*., 2015 Li *et al*, 2015 —	Systematic review.	Diversos professionals sanitaris.	28 studies, only 12 of which provide information about costs, only 21 studies with ICER.	Various.	Mean ICER: 13,761 USD/QALY gained.

HT: habitual treatment; WTP: willingness-to-pay; AUD: Australian dollar; DALY: disability-adjusted life year; ICER: incremental cost-effectiveness ratio; LSC: lifestyle changes; QALY: quality-adjusted life years.

Cardiovascular risk and cardiovascular risk factors

Table 5 details the studies that analysed the cost-effectiveness of dietary treatment for cardiovascular risk factors. Lin *et al.* [85], in the USA, designed a model (model of disease progression over twenty five years) to determine whether the dietary advice given to overweight or obese adults with a known risk factor for cardiovascular disease (abnormal baseline glucose level, hypertension, dyslipidaemia or metabolic syndrome) was cost-effective. The results showed that 44% of the North American population (98 million adults) would be candidates for a program like this, and they observed that in comparison with the intervention, the economic cost would be 13,900 USD/QALY, with variations in patient subgroups, from a saving of 302 USD per capita in people with obesity and abnormal baseline glucose levels, hypertension and dyslipidaemia, up to a cost of 103,200 USD/QALY in overweight people without associated comorbidities. They concluded that the intervention diet, with the standard willingness-to-pay (WTP) cut-off value of 50,000 USD/QALY, was cost-effective.

The results of the intensive diet and physical activity program carried out by nursing and physiotherapy professionals showed that the program was effective, but not cost-effective.

Eriksson *et al.* [86] conducted a study in PC with people with moderate to high cardiovascular risk, randomizing the individuals into standard intervention or an intensive diet and physical activity program, conducted by D-N and physiotherapists. The savings were 47 USD per participant, and the cost per QALY gained was 1,668 to 4,813 USD. The probability that the program was cost-effective was 89-100% when a WTP cut-off value of 50,000 USD/QALY was used, and therefore the program was very cost effective. Also in PC with people with high cardiovascular risk, Mistry *et al.* [87] published the analysis results of the cost-effectiveness study EUROACTION (Primary Prevention Program in cardiovascular diseases coordinated by the nursing service), where 2,024 people were randomly placed into the PC standard program or intensive program coordinated by the nursing service. Although the cost analysis associated with the QALY gained was favourable to the intervention, after

The results of the cost-effectiveness analysis of the EUROACTION study (Program of primary prevention of cardiovascular diseases coordinated by nurses), would only be cost-effective in less than 6% of the cases.

controlling for differences between groups in age, sex, baseline risk factors, etc., the intervention was associated with higher costs and fewer QALY than the standard treatment, and with a threshold of 20,000 £, the EUROACTION program would only be cost-effective in less than 6% of cases. Therefore, the authors concluded that the limitations of the study design and the statistical model used do not allow clear conclusions to be drawn and recommend more studies.

Saha *et al.* [88] studied 145 people, who were randomly placed into the usual PC treatment or in an intensive program for lifestyle changes carried out by D-N and physiotherapists. The intervention group obtained a 0.46 QALY gain in comparison with the control group, and the authors concluded that the intervention was cost-effective. Van Wier *et al.* [89] studied 622 people with risk of T2DM or cardiovascular disease for two years. The people were randomly placed into a standard treatment or intensive lifestyle change treatment carried out by nurses. The gain in QALY meant that the authors valued this intervention as not cost-effective. Smith *et al.* [90] compared the cost effectiveness of the modified Diabetes Prevention Program and the usual treatment in people with metabolic syndrome. In one year, while the usual treatment reduced the risk related to metabolic syndrome by 12.1%, the Diabetes Prevention Program reduced it by 16.2%, and achieved a gain of 0.01 QALY (3.67 days) at a cost of 3,420 / QALY. In 2005, Olsen *et al.* [91] published a cost-effectiveness analysis of dietary advice in people with obesity or the risk of ischemic heart disease. They compared the effect of the dietary advice provided by a D-N or by a PC doctor, and found that with the doctors the people achieved 0.0919 Life Years Gained (LYG) compared to 0.0274 LYG with the D-N, and the cost-effectiveness ratios were 8,213 DKK (Danish crowns) / LYG (doctors) compared to 59,987 DKK / LYG (D-N). Therefore, the authors concluded that treatment with PC doctors was most cost-effective, although the cost associated with the treatment conducted by D-Ns could be acceptable.

Given the economic benefits shown in New Zealand, D-Ns were included in PC, as they could save the National Health System 5.50 NZ$ to 99 NZ$ for each NZ dollar invested in dietary intervention.

Howatson *et al.* 2015 [50] published a systematic review to determine whether the PC dietary intervention was effective and cost-effective, including studies published between 2000 and 2014. Only four studies could be included in the economic analysis (a study with a cost-benefit analysis, two non-randomized studies and a systematic review). Economic benefits were observed in all four publications and it was therefore recommended to include D-Ns into the PC in New Zealand, since

they could save the National Health System 5.50 NZ$ to 99 NZ$ for each NZ dollar invested in a dietary intervention.

Dalziel *et al.* [92] analysed the cost-effectiveness of different dietetic-nutritional treatments (though not all were carried out in PC or clinical areas). The eight interventions subjected to economic analysis (Mediterranean diet, low-fat diet, intensive program in lifestyle changes, nutritional counselling at the PC centre, nutritional education provided by nurses at the PC centre, the «2 fruits and 5 vegetables a day» campaign, nutritional intervention media campaign and lifestyle changes program in the workplace) can be considered cost-effective and most were very cost-effective according to WHO criteria. The Mediterranean diet and the intensive changes in lifestyle program were the two most cost-effective interventions.

Sikand *et al.* [93] published a systematic review in which they assessed the clinical effectiveness and made a cost-benefit analysis of the D-N nutrition therapy given to people with dyslipidaemia. The results showed an improvement in QALY (+ 0.75 to 0.78 QALY with the treatment) and a reduction of 638 $ to 1456 $ per person per year in medication, associated with improvements in the clinical targets (from 6 % to 13 % reduction of total cholesterol and LDL cholesterol, 11 % to 22 % reduction of triglycerides, a 4 % increase in HDL cholesterol and a 4 % reduction in BMI).

Table 5
Economic studies of nutritional treatment in people at cardiovascular risk

Study	Study type	People in charge of the intervention programme	Size of the sample and length of follow up	Description	Results
Lin *et al*., 2017 United States	Simulation model.	—	—	Various nutritional interventions in people with CVRF.	Cost of the intervention: 262 USD; gain: 0.019 QALY/ person; 13,900 USD/QALY gained.
Eriksson *et al*., 2010 Sweden	Randomized controlled trial.	Dietician-nutritionist + physiotherapists.	N = 151 men and women (18-65 years) moderate-to-high CVR. 3 years.	HT *vs*. HT + intervention with LSC.	Saving: 47 USD/participant. 1,668-4,813 USD/QALY gained (without discounting the saving). 89-100% probability of being effective with WTP 50,000 USD.
Mistry *et al*., 2012 Europe	Randomized controlled trial.	Nursing.	N = 2,024 with no cardiovascular disease. 1 year.	HT *vs*. Intervention with the Programme «EUROACTION».	Intervention costs: £362-419 0.076-0.085 QALY gained. ICER: £5,539-4,266/QALY gained.
Saha *et al*., 2013 Sweden	Randomized controlled trial.	Dietician -nutritionist + physiotherapist.	N = 145. 3 years.	HT *vs*. intensive programme with LSC	–0.43 QALY (HT) *vs*. 0.03 QALY (LSC); total of 0.46 QALY gained.
van Wier *et al*., 2013 Holland	Randomized controlled trial.	Nursing.	N = 622 people at risk of DM2/CVD. 2 years.	HT *vs*. intensive programme with LSC	Intervention: 0.02 more QALY (not significant) than controls.
Smith *et al*., 2010 United States	Simulation model.	—	—	«Diabetes Prevention Program».	0.01 QALY gained. 3,420 USD/QALY gained. 78% of the models cost less than 20,000 USD/QALY gained.
Olsen *et al*., 2005 Denmark	Randomized controlled trial.	Dietician -nutritionist.	N = 503 people. 1 year.	Dietary advice from PC doctor *vs*. D-N.	0.0919 LYG (doctors) *vs*. 0.0274 LYG (D-N). ICER: 8,213 DKK/LYG (doctors) *vs*. 59,987 DKK/LYG (D-N).
Howatson *et al*., 2015 New Zealand	Systematic review.	Dietician -nutritionist.	21 studies (8 RCT, 6 non RCT, 3 reviews), economic analysis only in 3 studies and 1 review).	LSC *vs*. HT.	Saving: $5.50–99 NZ for every $NZ invested in dietary intervention.
Dalziel *et al*., 2007 Various	Literature review.	Various.	—	8 different nutritional interventions.	Mediterranean diet: 1,020 AUD/QALY gained. Low-fat diet: 10,000 AUD/QALY gained. Intensive programme with LSC: 1880 AUD/QALY gained. Nutritional advice from PC: 10,600 AUD/QALY gained. PC nursing: 12,600 AUD/QALY gained. “2 fruits and 5 greens”: 46 AUD/QALY gained. Nutritional intervention in the media: 5,600 AUD/QALY gained. LSC in the workplace: 19,800 AUD/QALY gained.
Sikand *et al*., 2018 Various	Literature review.	Dietician -nutritionist.	34 studies, only 7 with economic data.	Nutritional intervention by D-N in people with dyslipidemia.	+ 0.75 to 0.78 QALY with the treatment and a reduction of $638 to $1456 per people and year in medication.

HT: habitual treatment; WTP: willingness-to-pay; AUD: Australian dollar; DALY: disability-adjusted life years; ICER: incremental cost-effectiveness ratio; LSC: lifestyle changes; DM2: diabetes mellitus type 2; CVRF: cardiovascular risk factors; CVD: cardiovascular disease; PC: primary care; QALY: quality-adjusted life years; D-N: dietician-nutritionist; LYG: life-years gained; DKK: Danish crown.

Healthy people and others

There is also evidence for healthy people (Table 6). For example, Emmons *et al.* [94] compared the effectiveness on the multiple risk behaviour score of an intervention that was either self-guided or supported through two telephone calls. The intervention was centred on physical activity, eating fruit and vegetables, eating red meat, the use of multivitamin supplements and stopping smoking, and the usual PC treatment. The two versions of the intervention improved the multiple risk behaviour score compared to the usual treatment without significant differences between them. The increase in the cost-effectiveness ratio for improving one unit in the multiple risk behaviour score was 319 USD for the self-guided intervention, and 440 USD for the intervention with support telephone calls. The self-guided and supported interventions showed equivalent reductions of the various risk factors for chronic illness, and a relatively low cost. Therefore, they are potentially useful for routine implementation in similar healthcare environments.

Several studies show greater effectiveness if dietetic-nutritional treatment is carried out by a D-N (the healthcare expert in dietary advice), improving the possibility of people sticking to lifestyle changes, achieving more clinical objectives (weight, cholesterol, etc.), improving quality of life and life expectancy, and obtaining greater economic performance.

Gulliford *et al.* [95] also designed a model that included 262,704 healthy people to study whether the nutritional treatment of a balanced diet in healthy people carried out by PC could be cost-effective. The intervention was associated with an increase in years lived without disease of 41.9 / 1000 inhabitants, and the new incidences of diseases were reduced in 28.4 / 1,000 inhabitants. In the cost-utility analysis, only when people 50-74 years old were chosen did the probability that the treatment would be cost-effective increase. The authors propose, therefore, to direct the PC nutritional treatment at older people and those with a high risk of diseases to improve the effectiveness of the nutritional treatment.

In participants with chronic constipation, Speed *et al.* [96] studied the clinical effectiveness and the cost-effectiveness ratio of laxatives (control group) compared to standardized, but not customized, dietary advice and lifestyle recommendations, and personalized and reinforced dietary advice and lifestyle recommendations. Due to the low number of participants in the process, the author could not draw

firm conclusions about the clinical effectiveness of the interventions. The data on costs related to healthcare show a savings of £13.34 for those who received personalized advice, in comparison with the control group, and less cost savings for the group who received standardized, non-personalized dietary advice. These savings were due to hospital costs being reduced. No significant changes were found, although the personalized group produced the largest cost savings.

The nutritional treatment of a balanced diet in healthy people led by PC is more cost-effective in older people (50-74 years).

Malnutrition in Primary Care

The evidence of cost-effectiveness of a dietary treatment for malnutrition in PC is shown in Table 7. Schilp *et al.* [97] (2014) compared the cost-effectiveness of a dietetic treatment at PC centres with the usual care in undernourished people ≥65 years old living independently. The dietary treatment led by a D-N combined face-to-face and phone consultations. The number of consultations depended on the nutritional situation and the needs and wishes of the participant. After six months, no significant differences in body weight, QALY or total cost were observed between the group that received dietary treatment and the group with standard treatment. The cost-effectiveness analysis showed that the dietary treatment conducted in this study was not effective for body weight or for quality of life compared with the usual treatment. That there were no effects could be explained by a limited intensity (2.4 hours in the intervention group and 0.2 hours in the control group) and the short duration of the treatment. More consultation time is possibly necessary to achieve an increase in body weight. In addition, the duration of the monitoring could have been too short for the intervention to have a positive effect on life quality. Another limitation of this study is that it was designed to be able to detect differences in body weight, but it did not have the statistical power to detect differences in cost [97]. This is a common problem of economic evaluations and to solve this problem a high number of participants is necessary [98]. Therefore, more studies are necessary that make it possible to evaluate the cost- effectiveness relationship of a dietary treatment in PC in malnourished people to deal with the epidemic of malnutrition.

Table 6
Economic studies of nutritional treatment in healthy people

Study	Study type	People in charge of the intervention programme	Size of the sample and length of follow up	Description	Results
Emmons *et al*., 2014 United States	Randomized controlled trial.	Not mentioned.	N =2,440 participants of ≥18 years not diagnosed as suffering from dementia, blindness, neurodegenerative disease or psychiatric in the last 5 years who are not being treated for cancer. 18 months.	HT *vs*. healthy intervention self-directed by the people (HD2) *vs*. healthy intervention + 2 coaching phone calls (HD2 + CC), on the multiple risk behaviour score.	The improvement of one unit in the multiple risk behaviour score was 319 USD per HD2, and 440 USD per HD2 + CC. In both groups the multiple risk behaviour score was better than with HT.
Guilliford *et al*., 2014 United Kingdom	Population-based cohort study.	—	262,704 healthy adults, with no chronic diseases recorded in PC.	Healthy diet.	QALY per 1,000 participants: –0.32; the probability that the treatment is cost-effective (£30,000 /QALY) is only 47.9%.
Speed *et al*., 2010 United Kingdom	Randomized controlled trial.	The dietician -nutritionist gives training sessions for the health professionals taking part in the study.	N = 154 participants of ≥ 55 years with chronic constipation. 12 months.	Laxatives *vs*. dietary advice and standard, non-personalised LSC vs dietary advice and personalised LSC.	A saving of £13.34 in the personalised group compared to the control group. The saving was less in the standard group.

HT: habitual treatment; LSC: lifestyle changes; QALY: quality-adjusted life-years; PC: primary care.

Table 7
Economic studies of nutritional treatment in undernourished people

Study	Study type	People in charge of the intervention programme	Size of the sample and length of follow up	Description	Results
Schilp *et al*., 2014 Netherlands	Randomized controlled trial.	Dietician -nutritionist.	N = 146 undernourished people of ≥65 years old who live independently. 6 months.	Dietary treatment group (combination of face-to-face and phone consultations) *vs*. HT.	No statistically significant differences are observed in the effect of the treatment or in total costs between the intervention groups.

HT: habitual treatment.

CONCLUSIONS

There are published systematic reviews that evaluate the cost-effectiveness relationship of dietetic-nutritional treatments that positively value the economic investment in this kind of treatment compared to the usual treatment. The data obtained in ICER, QALY and WTP show that the investment is cost-effective. However, the majority of authors believe that it is necessary to do more research to draw clear conclusions. There are several methodological limitations that are responsible for this. First, the sample size often does not provide enough statistical power to draw clear conclusions or the main objective of the study design is not cost. The differences in the populations studied (heterogeneous populations, not always in PC or with different basic pathologies, etc.) also make it difficult to extract appropriate conclusions for PC. The different study methodologies (cost-utility analysis, cost-effectiveness analysis or cost-utility analysis, or even in some studies only a cost minimization analysis) are another factor of variability in the results obtained. Similarly, intervention studies have varying results (most results are favourable to dietetic-nutritional treatment, though some results are not favourable to intensive dietary interventions, especially when they are not conducted by a D-N but rather other health professionals).

Another possible confounding factor in analysing the cost-effectiveness relationship of dietary and nutrition treatment in PC is the person in charge of the dietary intervention, since there are few interventions conducted by experts in diet advice: the D-N. Of the publications analysed in this review only two studies analysed interventions for excessive weight and obesity conducted by a D-N (both with positive cost-effectiveness ratio results); no studies analysed interventions for T2DM carried out by a D-N; and only three studies (two with positive results) and two systematic reviews analysed interventions for people with cardiovascular risk conducted by a D-N. All interventions had positive economic results in favour of the nutritional intervention. Therefore, several studies show that the intervention is more effective if the dietary treatment is carrying out by a D-N (the health professional expert in dietary advice), as this improves compliance with the lifestyle changes, the achievement of more clinical objectives (weight, cholesterol, etc.), the improvement of life quality and life expectancy and better economic performance [61]. The PC medical and nursing professionals have limited time to attend to each person, and this often makes it difficult to allocate a specific time in each visit to dietary treatment and changes in physical activity. Incorporating the D-N would make it possible to assess the personal situation of each person with a chronic disease, set individual goals and motivate the lifestyle change.

It should also be noted that there are many factors that limit the dietary treatment as well as compliance with the treatment, including socio-cultural factors, the way

the intervention is made (email, telephone call, individual or group visit, information brochure), the intensity of the treatment (weekly, monthly, quarterly, etc.), the duration of the treatment and even the content. All of these factors can vary the effectiveness of the clinical objectives, and therefore affect the effectiveness of the economic analysis. The D-N is a professional capable of discerning, in each specific case, what would be the most recommendable therapeutic option.

Therefore, incorporating the D-N into PC would have, among others, the following benefits:

1. Capacity to people in order to self-control their chronic diseases through dietary guidelines.
2. Better life quality for people with chronic diseases.
3. Less demand for specialized medical care for people with chronic diseases.
4. Less demand for medical visits.
5. A reduced need for hospitalization for people with cardiovascular disease.
6. Less prescription of medicines.
7. The reduction of work sick days.
8. The possibility of starting and participating in the prevention of chronic diseases and promoting health in the PC community.
9. The possibility for people to self-manage their chronic disease by following dietary guidelines.

Finally, it is necessary to emphasize that recently the European Commission has published the report *A New Drive for Primary Care in Europe: Rethinking the Assessment Tools and Methodologies* elaborated by the Expert Group on Health Systems Performance Assessment [18], which shows that primary care should be enhanced with an evaluation of performance and good functioning that encompasses all the health professions that work in multidisciplinary teams, including the D-N.

CODINUCAT RECOMMENDATIONS

In view of the results obtained in this review and the situation of the D-N in PC in other countries around the world, we believe it is absolutely necessary to steadily incorporate the D-N into PC.

The incorporation of the D-N into the PC can be staggered, evaluating the possibility of implementing the following models described in international experiences:

- **a** A D-N every 20,000 health cards
- **b** A D-N for each of the different integral networks of PC of Catalonia.
- **c** Non-daily collaboration of a D-N, one day a week in different PC teams.

The incorporation of the DN into PC will enable the population to access the best qualified healthcare professional to carry out dietary and nutritional treatment for various pathological states and for the promotion of health and the prevention of disease individually and in the community.

In addition, incorporating a D-N in PC will improve the life quality and expectancy of the population, reduce the risk of all the chronic diseases related to nutrition (obesity, T2DM, hypertension, etc.) and at the same time offer cost-effective treatment in terms of health expenditure.

Therefore, we consider the incorporation of the D-N into PC an investment in individually and in community health.

FUNDING AND DECLARATION OF POTENTIAL CONFLICTS OF INTERESTS

The CODINUCAT members Isabel Megías-Rangil and Patricia Casas-Agustench declare that they have received fees for the commission to carry out this review.

Nancy Babio, as the president of the CODINUCAT Governing Board and author of this review, declares that she has not received any compensation and has no conflict of interests.

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